MODERN AUTOMATIC ELECTRICALLY CONTROLLED ELEVATORS FOR TRANSPORTING MEN AT TWO COAL MINES IN WESTERN PENNSYLVANIA

BY J. W. HOLCOMB

* * * * * * * * * **Information Circular 7628**

MARCH 3, 1849

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
J. J. Forbes, Director

Work on manuscript completed September 1951. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7628."

A 01419

January 1952

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INTRODUCTION

Many mines are opened into the coal beds by shafts; and, at some of these operations, the same cages or skips that are used for hoisting coal also are used for transporting men into and out of the mines. At some mines, separate man-and-material shafts are maintained, and the cages in these are utilized for transporting men and supplies only. In most instances, these cages are operated either singly or in pairs by a hoisting engine installed in a building near the shaft. Single ropes from the tops of the cages pass over bull wheels on the head frame to either electrically or steam-driven hoisting engines that require engineers to operate them. There are records of several instances where hoisting engineers have become incapacitated suddenly while hoisting men, and the passengers on the cages were killed or injured. Where the same cages are used for hoisting cars of coal and for lowering and hoisting men, especially where self-dumping cages or skips are used, safety precautions must be taken, such as providing steel bonnets for the cage deck, enclosed sides, adequate handholds, gates for closing the end openings, safety catches, and locking devices to prevent accidental dumping.

Some of the newer hoisting installations are of the elevator type, where an operator rides in the cage in the same manner as an elevator operator in a building. These cages have single or multiple decks and are primarily for transporting men; but, in some instances, supplies also are transported. They are a great improvement over the installations where the same cages are used for hoisting cars of coal and transporting men.

Additional improvement has been achieved at some mines where automatic electrically controlled elevators have been installed for transporting men in shafts, such as those at the Lewis mine of the Pine Run Co., Vandergrift, Westmoreland County, Pa., and at the Butler Junction mine of the Butler Junction Coal Co. near Freeport, Allegheny County, Pa.

The officials of these companies, contemplating the need for additional air shafts near the active working sections of the mines, decided that the shafts, when sunk, could be utilized as a means of ingress and egress for men working in the mines. It was their desire not to install conventional-type cages designed primarily for hoisting cars of coal and materials. Investigations and studies by the officials indicated that a large elevator, similar in operation to those used in large buildings, would be more convenient for the workmen and would be more economical in first cost, maintenance, and operating costs. The elevators chosen for installation in these mine shafts are considered by the coal-company officials to be as nearly foolproof as possible, because of the many safety features included in their installation.

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A study of these installations was made, and the information obtained is presented in this report for the benefit of other mine operators who might find it advantageous to provide similar facilities.

ACKNOWLEDGMENT

The author wishes to express his gratitude to the officials of these companies for their assistance in obtaining this information and permission to use it. Special acknowledgment is given to L. W. Hicks and W. A. Hicks, presidents; George H. Ritchie, chief electrician; William Barclay, superintendent of Lewis and Butler Junction mines; Steve Slivan, mine foreman, Lewis mine; and James McKay, mine foreman, Butler Junction mine.

SHAFTS

The Pine Run shaft of the Lewis mine, approximately 5 miles southwest of Vandergrift, Pa., is concrete-lined, 307 feet deep, 12 feet 4 inches wide by 30 feet long inside, and provided with a series of water rings to keep the shaft dry and a 12-inch masonry partition so that in the future the 9- by 12-foot 4-inch compartment can be used as an intake or return airway when a fan is installed. (See fig. 1.) The shaft was extended 31 feet above the surface over the 12-foot 4-inch by 20-foot compartment by masonry construction (fig. 2), and 21 feet above the surface landing in this extension a reinforced concrete floor was provided to support the hoisting equipment. The room over this floor is called a penthouse and encloses the elevator motor, electric brake, reduction gear, drive and deflector sheaves, governor, and control panels (figs. 3 and 4). In part of the shaft compartment below the penthouse, along the masonry partition, a 12-foot 4-inch by 5-foot 5-inch area, provided with a steel stairway with landings every 8-1/2 feet (fig. 5) and screened for the remaining part of the compartment, provides a means of ingress and egress for the employees in the event of failure of the elevator to operate.

The Butler Junction shaft, approximately 5 miles west of Freeport, Allegheny County, Pa., is concrete-lined, 259 feet deep, 12 feet 4 inches wide and 22 feet long inside and is provided with a 12-inch masonry partition that isolates a compartment 12 feet 4 inches by 7 feet 10 inches, which will most likely have a fan installed at the top of it at some future date.

CAGES

The cages or elevator cars at both of these installations are of steel. The one at the Pine Run shaft is 8 by 10 feet in inside floor area and will accommodate 32 persons at one time. The one at the Butler Junction shaft is 7 feet 5 inches by 10 feet in inside floor area and will accommodate 28 persons at one time. However, the Pennsylvania Department of Mines permits only 30 persons at one time on the car in the Pine Run shaft and 25 persons on the one in the Butler Junction shaft. The cars are enclosed completely and equipped with automatic motorized doors and gates. The cars travel 375 feet a minute in the shafts, slowing to about 62.5 feet a minute within 10 feet of the top and bottom landings. The height of the cars (inside) is 7-1/2 feet (fig. 6). Electric lights are provided in, on top, and under the cars.

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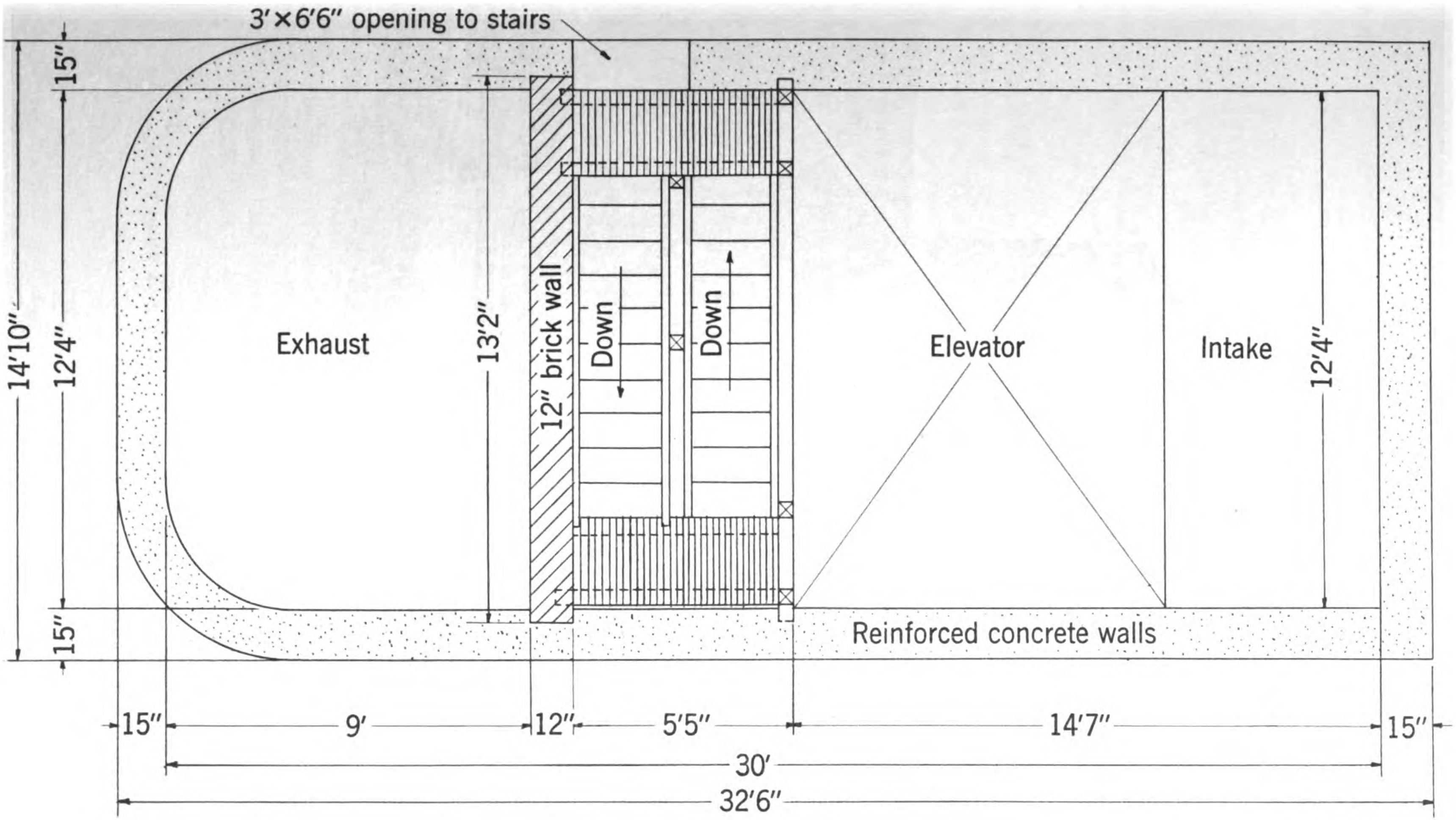

Figure 1. - Cross section through shaft.

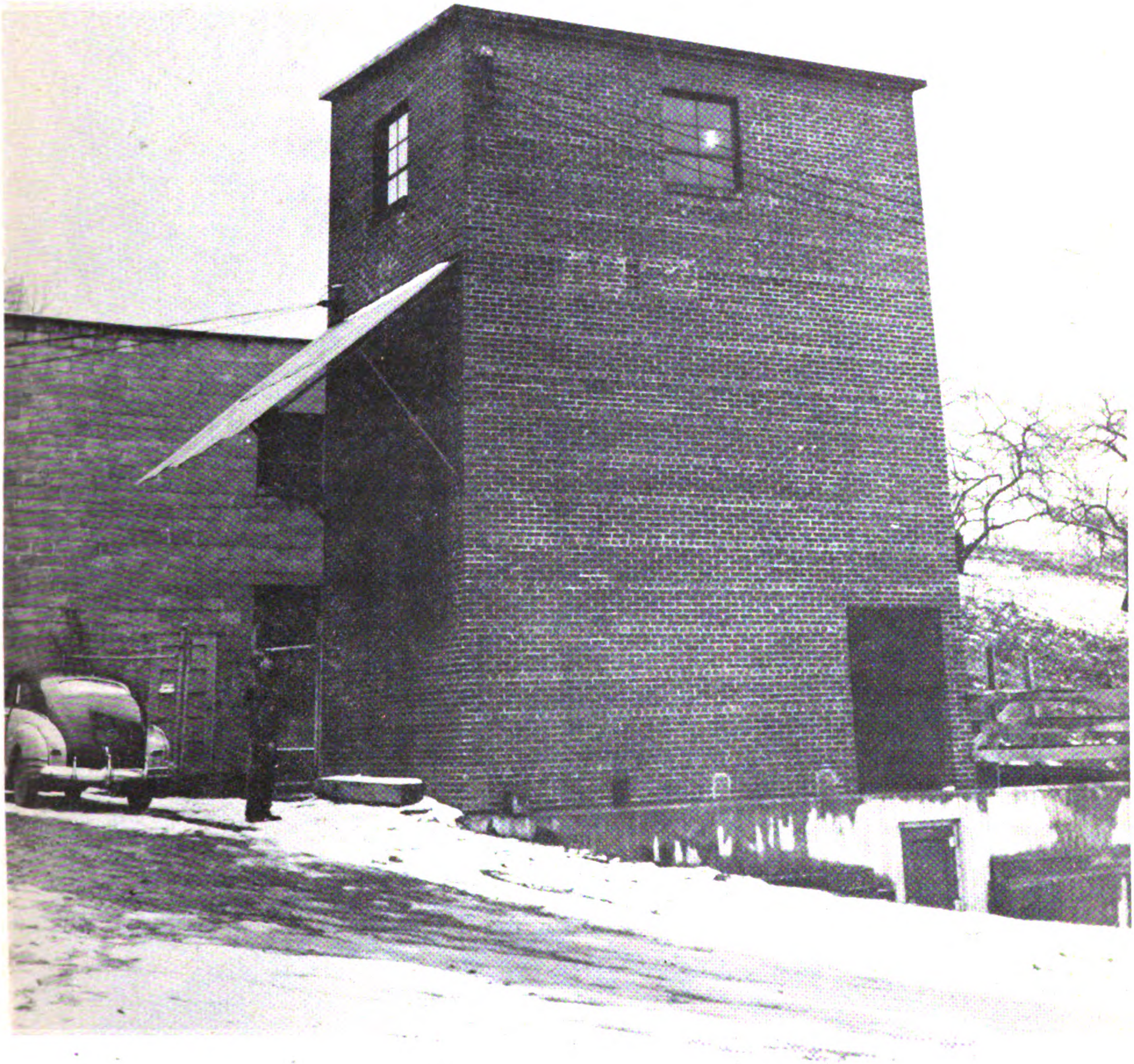

Figure 2. - Shaft extension containing penthouse.

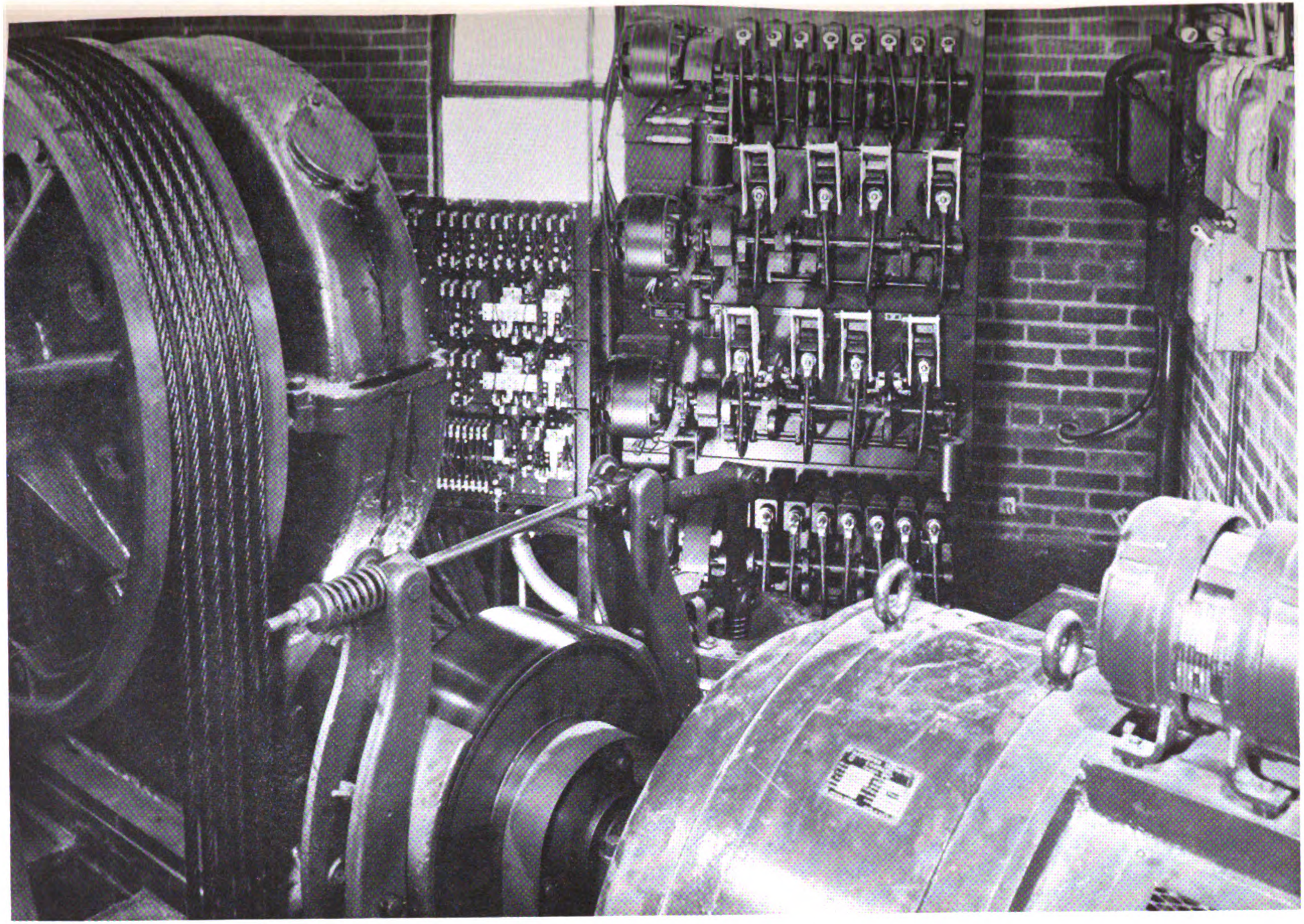

Figure 3. - Drive sheave, ropes, brake, and control panels.

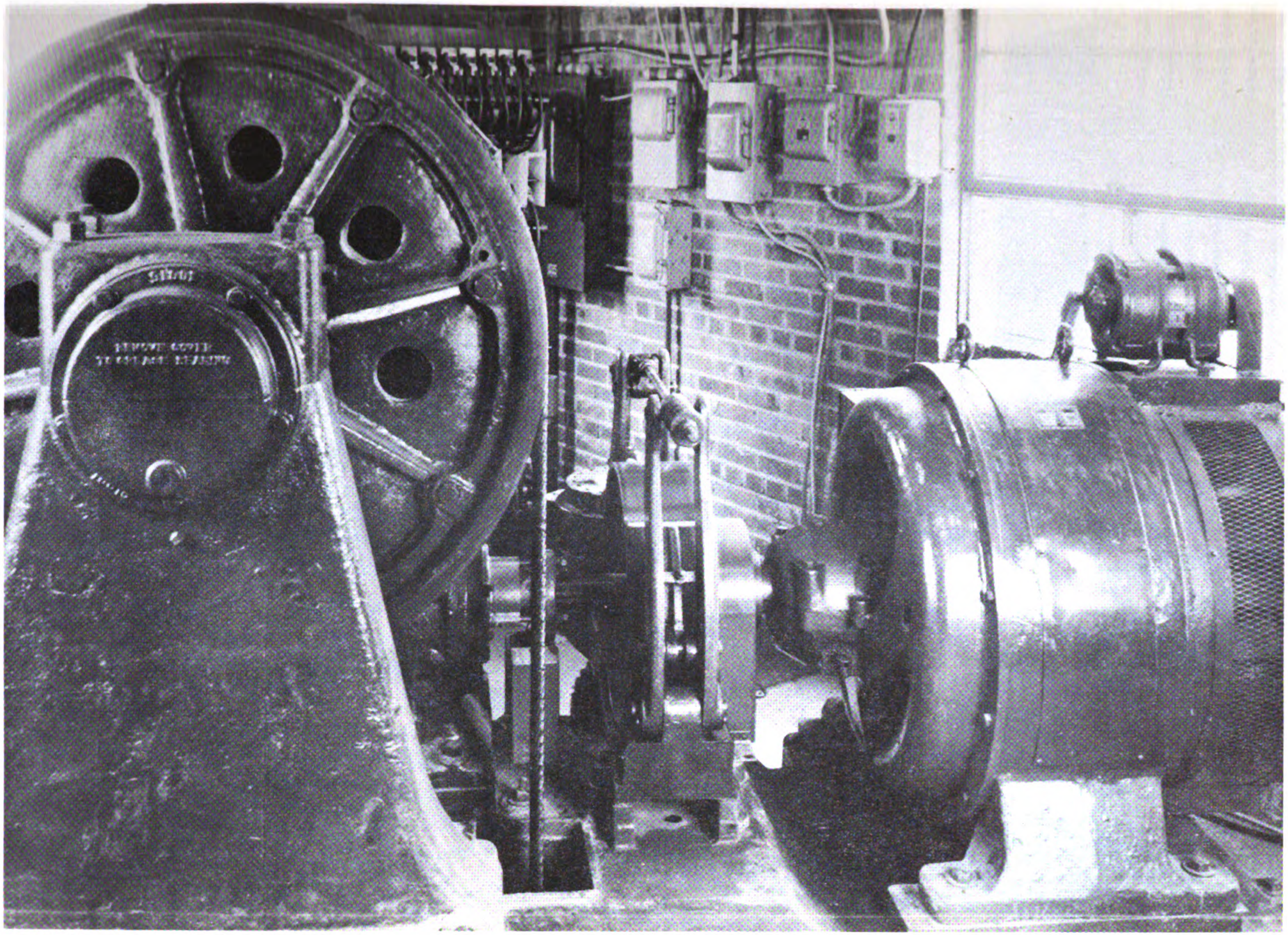

Figure 4. - Drive sheave, brake, and drive motor with auxiliary motor-driven fan.

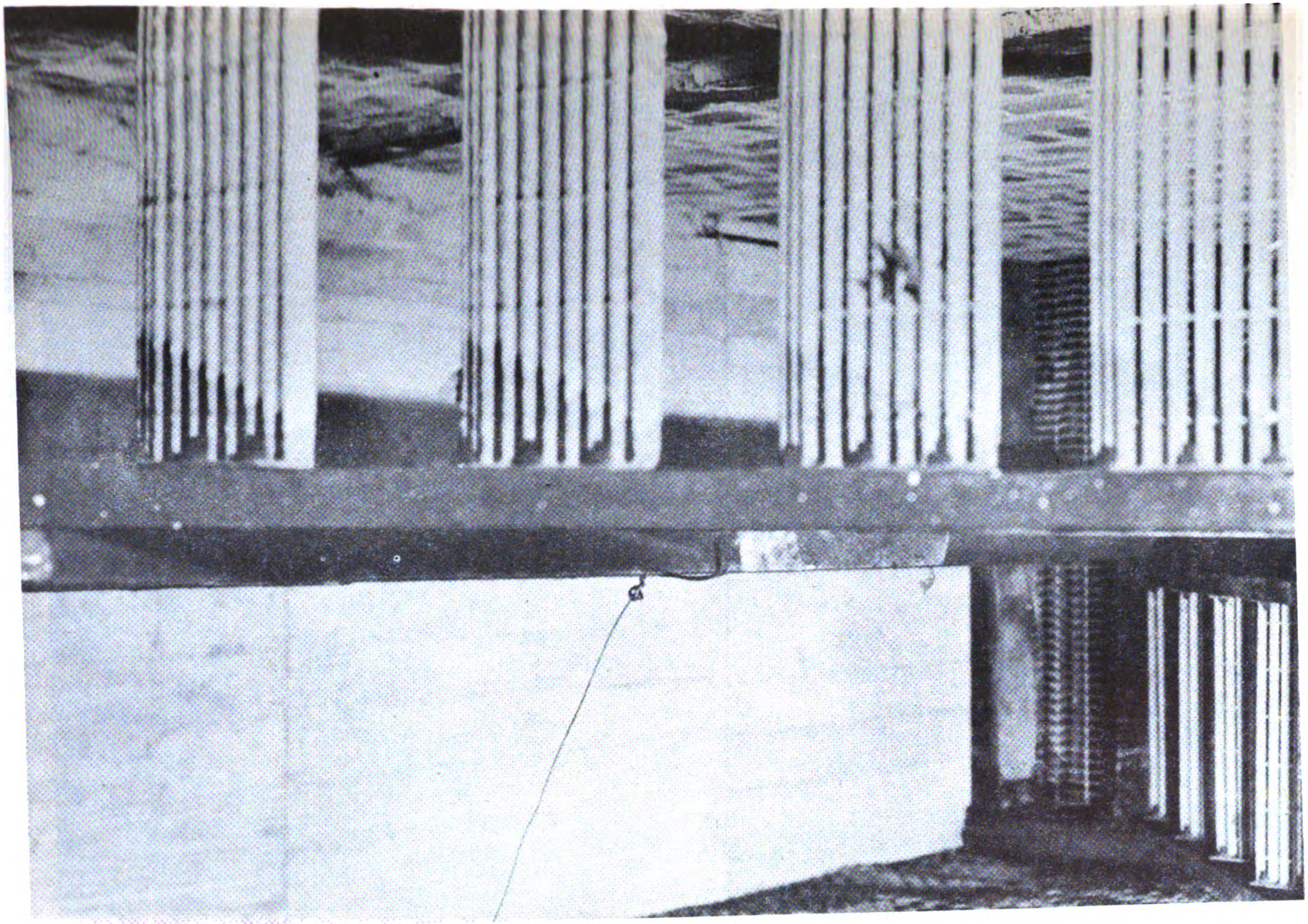

Figure 5. - View looking up stairway compartment, showing steel construction of stairway.

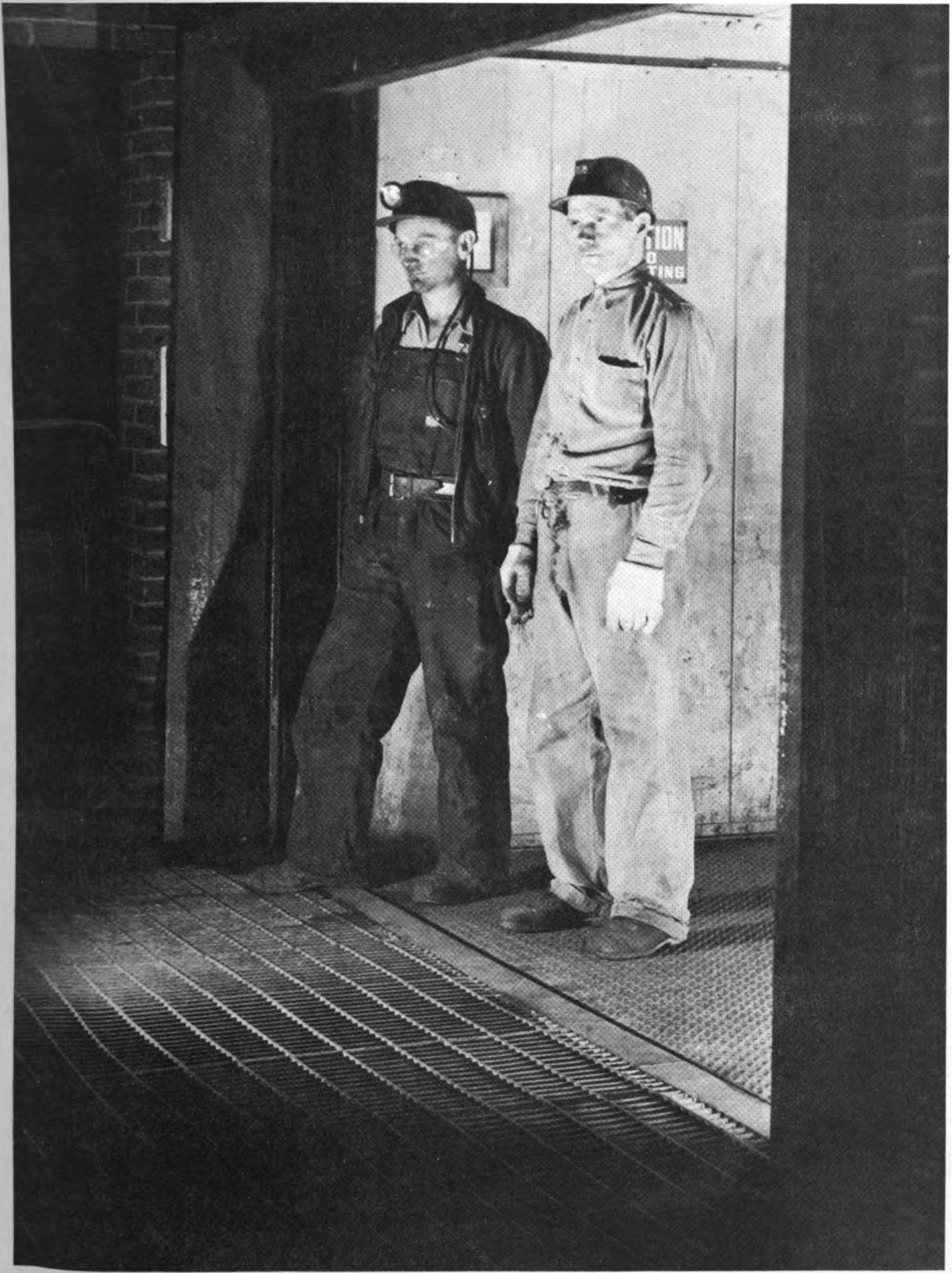

Figure 6. - Car at surface landing, with door and gate open.

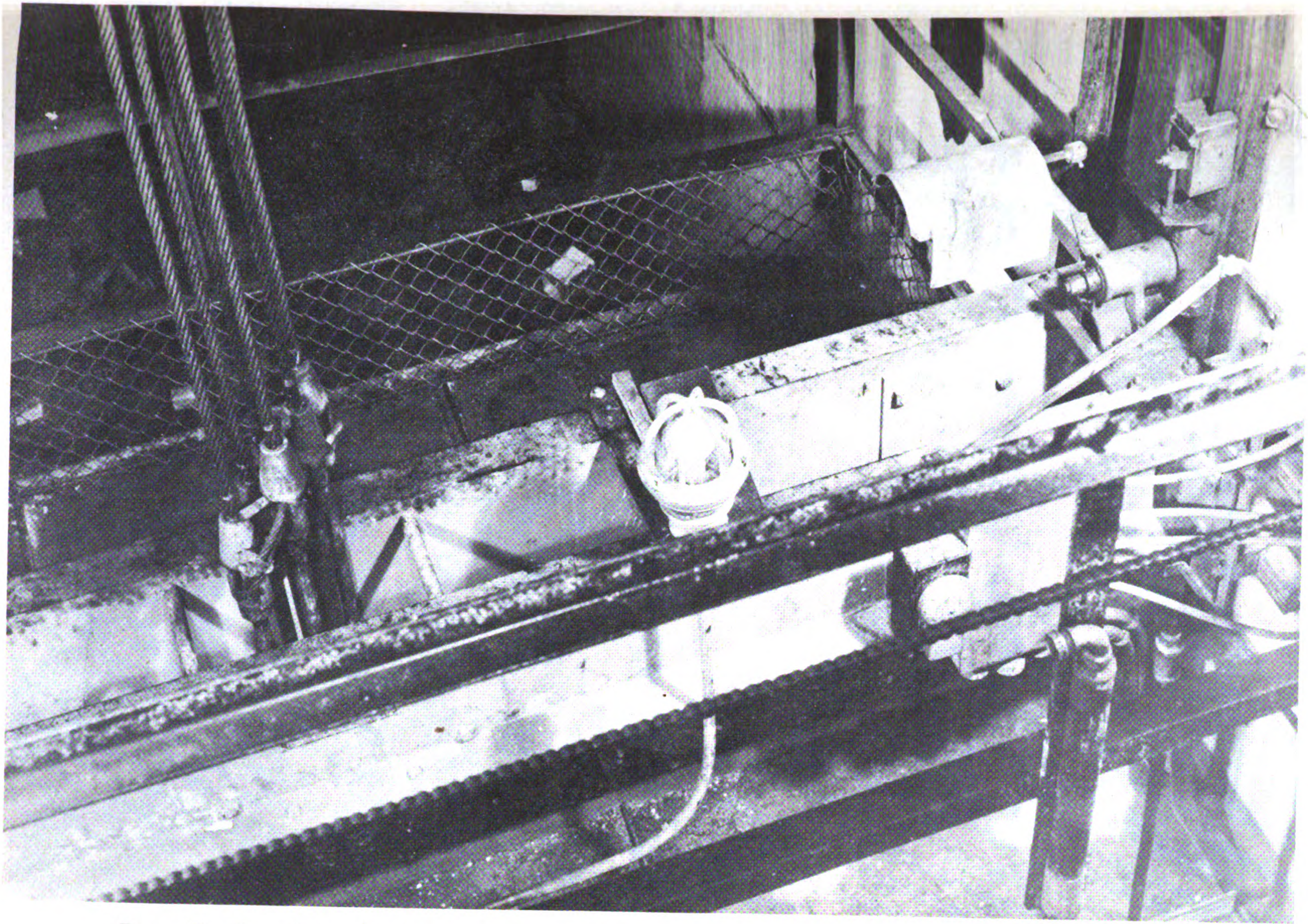

Figure 7. - Top of car, showing ropes, rope sockets, deceleration switch, car guides, and electric light.

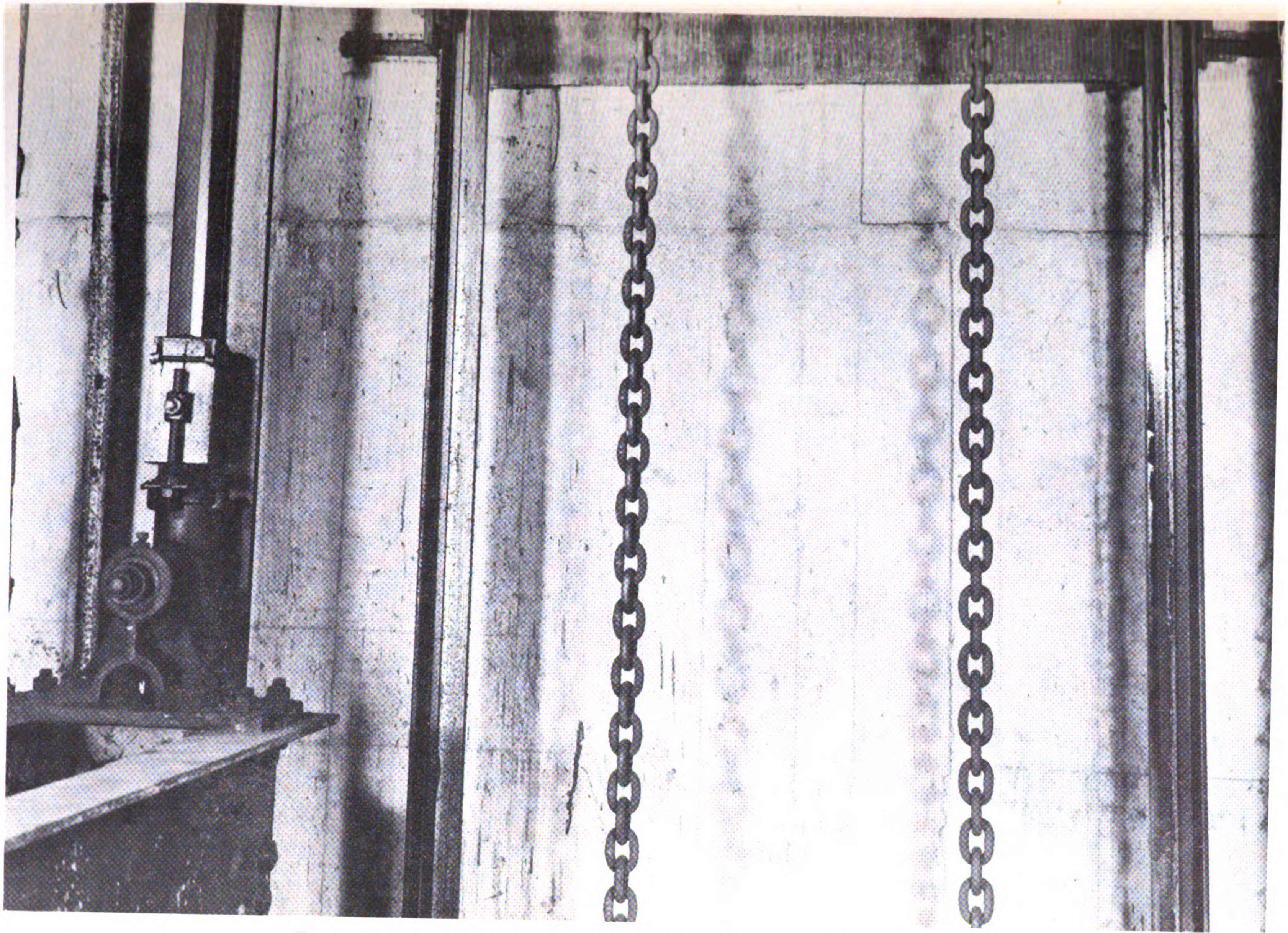

Figure 8. - Car and counterweight guides and counterbalance chains.

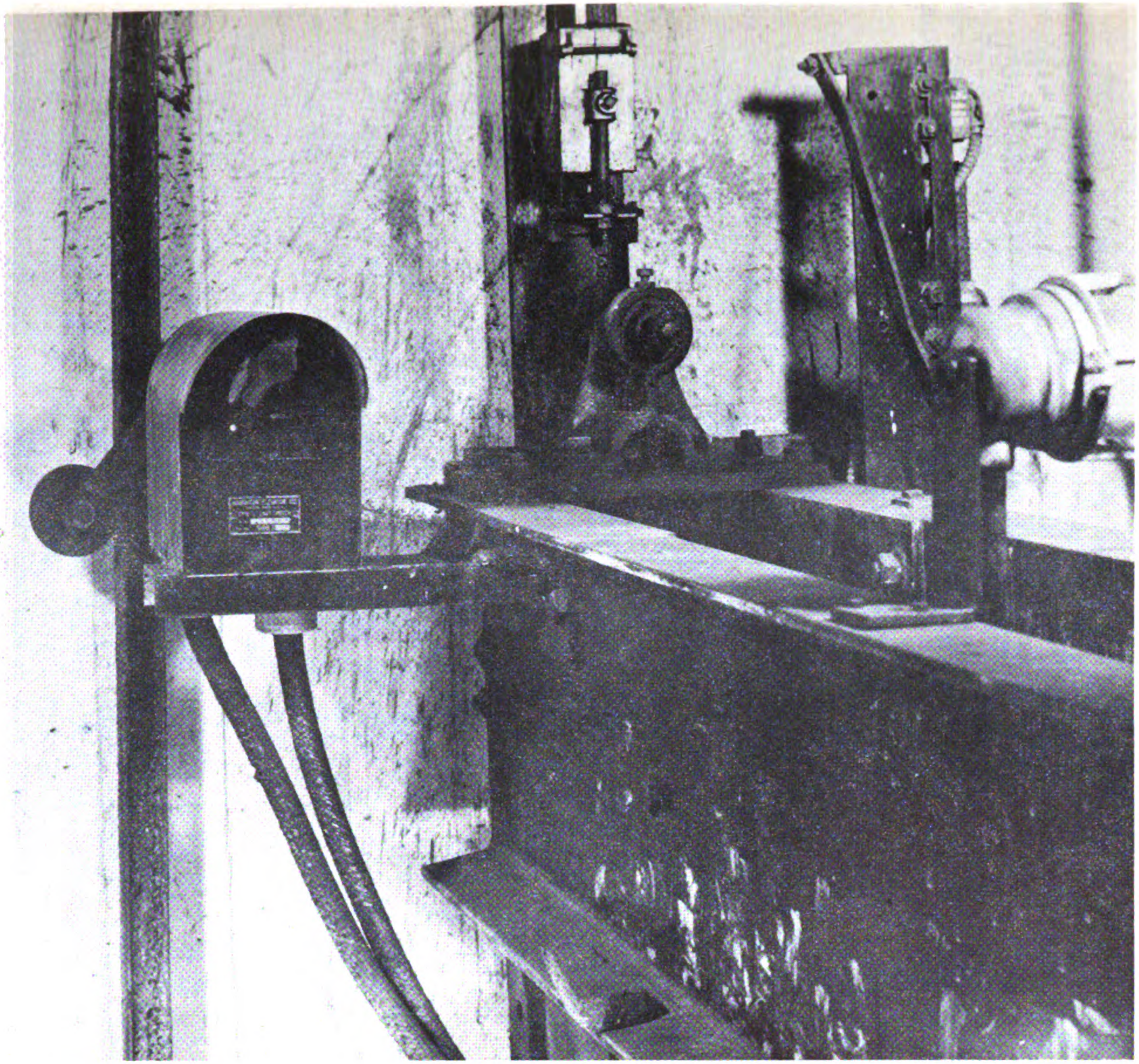

Figure 9. - View from top of car, showing car guide, deceleration switch, and stationary angle-iron deceleration cam on wall of shaft.

ROPES

The car in each shaft is supported by six 3/4-inch, 6 by 19 stranding, traction steel-wire ropes, each of which has a tensile strength of 32,000 pounds. Each rope is fastened to the top of the car independently and in a manner to equalize the load carried by each rope (fig. 7). The ropes are counterbalanced by two 7/16-inch chains that are fastened to the bottom of the car and to the bottom of the counterweights, and the chains have approximately the same weight as the six ropes.

COUNTERWEIGHTS

Iron counterweights, 40 percent heavier than the empty cars, are attached to the ends of the cage ropes and travel in guides installed on the shaft walls. The counterweights are pieces of iron, 6 inches by 3 feet, bolted together.

GUIDES

The guides for cars and counterweights are milled steel, T-shaped angles held together by fishplated tongue-and-groove joints and are securely fastened to the concrete walls of the shafts (fig. 8).

SHEAVES

The sheaves at each installation consist of a 46-inch-diameter, grooved, traction-type sheave and a 36-inch, grooved, deflector sheave. The six wire ropes attached to the top of each car pass over the drive sheave (fig. 3), located directly over the center of the car, thence over the deflector sheave, and down to the counterweights.

ELECTRIC POWER

The traction sheaves are driven through reduction gears (figs. 3 and 4) by 75-horsepower, 440-volt, 3-phase, alternating-current motors operated at speeds of 900/150 revolutions a minute; the motors turning 150 revolutions a minute when starting, running 900 revolutions a minute at full speed, and slowing down to 150 revolutions a minute before stopping. The drive motors are air-cooled by fans installed in the motor housings and belt driven by separate motors mounted on the top of the motor housings (fig. 4).

On the approach to landings near the top and bottom of the shafts the cars are decelerated by switches installed on top of the cars, which are actuated by stationary angle-iron cams located on the walls of the shafts. These cams are adjustable so that the deceleration can be started at any desired distance from the landings (fig. 9).

The main control panels are installed in the penthouse. The contactors in the main power circuit are operated by electric motors (fig. 3). Contactors are shown for two-speed operation in either direction. Relays in the control circuits are mounted on the panel adjacent to the main control panel. Push-button control switches on the cars are connected to relays on the control panel by means of flexible cables. These cables are suspended in the shaft with one end attached to the bottom of the car.

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OPERATION AND CONTROL

The operation of the elevator cars can be, by special arrangement, either completely automatic or semiautomatic. In complete automatic operation, the cars can be controlled from either the top or bottom landings by means of a push-button switch. In semiautomatic operation, an operator is required to ride in the car. The change from completely automatic to semiautomatic operation, or vice versa, requires a special key to be inserted in a lock inside the car. These keys are in the possession of officials only, so that operation of the cars cannot be changed without official consent.

The protection against overwind for these installations is considered to be positive under all conditions of operation. When the counterweight is down and resting on the oil-filled buffers at the bottom of the shaft, there is not enough traction between the hoisting ropes and the grooved traction sheave to hoist the car any farther. When the car is at the bottom of the shaft and resting on the oil-filled buffers (fig. 10), the traction between the ropes and the sheave is again lost, preventing any overwind.

A 16-inch fly-ball governor in the penthouse above each shaft provides overspeed control for the cars (fig. 11). The governor rope is 1/2-inch diameter, 8 by 19 stranding, with both ends attached to the overspeed device mounted under the floor of the car. The rope passes over the governor sheave, and, in case of overspeed, the governor first trips a switch disconnecting the electric power; if the car maintains its speed, the governor trips the cable gripper, which causes the overspeed device under the floor of the car to unwind and grip the guides, thereby stopping the car (fig. 12).

The cars are provided with automatic floor-leveling and final-limit controls. The electric circuits are connected in such a manner as to provide maximum protection against faults. The vertically operated steel-plate doors and gates are motorized and equipped with interlocks, which require the doors and gates to be closed completely before the cars can be operated. An adjustable cam switch controls the opening and closing of the doors and gates at the proper times. A safety edge is provided on the bottom of the doors to prevent closing if contact is made with a person or other obstruction. When a slight contact is made with the edge while closing, the doors immediately reverse and return to the open position. When the obstruction is removed, normal operation can be restored by actuating the start button.

BRAKES

The brakes on these installations are entirely automatic, with electrical release and gravity application. They are applied automatically when the cars reach the landings or upon operation of any of the safety devices or failure of power. A magnetically actuated shaft operates in an oilless bearing and an oilless dash pot and is adjustable for extremely smooth-braking operation (partly shown in figs. 3 and 4). As the car approaches the landings the deceleration switch causes the motor to be connected for low-speed operation and slows the travel of the car. At the landings, after the car has been leveled by the floor-leveling controls and as the electric-power circuits are deenergized, the brake is applied automatically.

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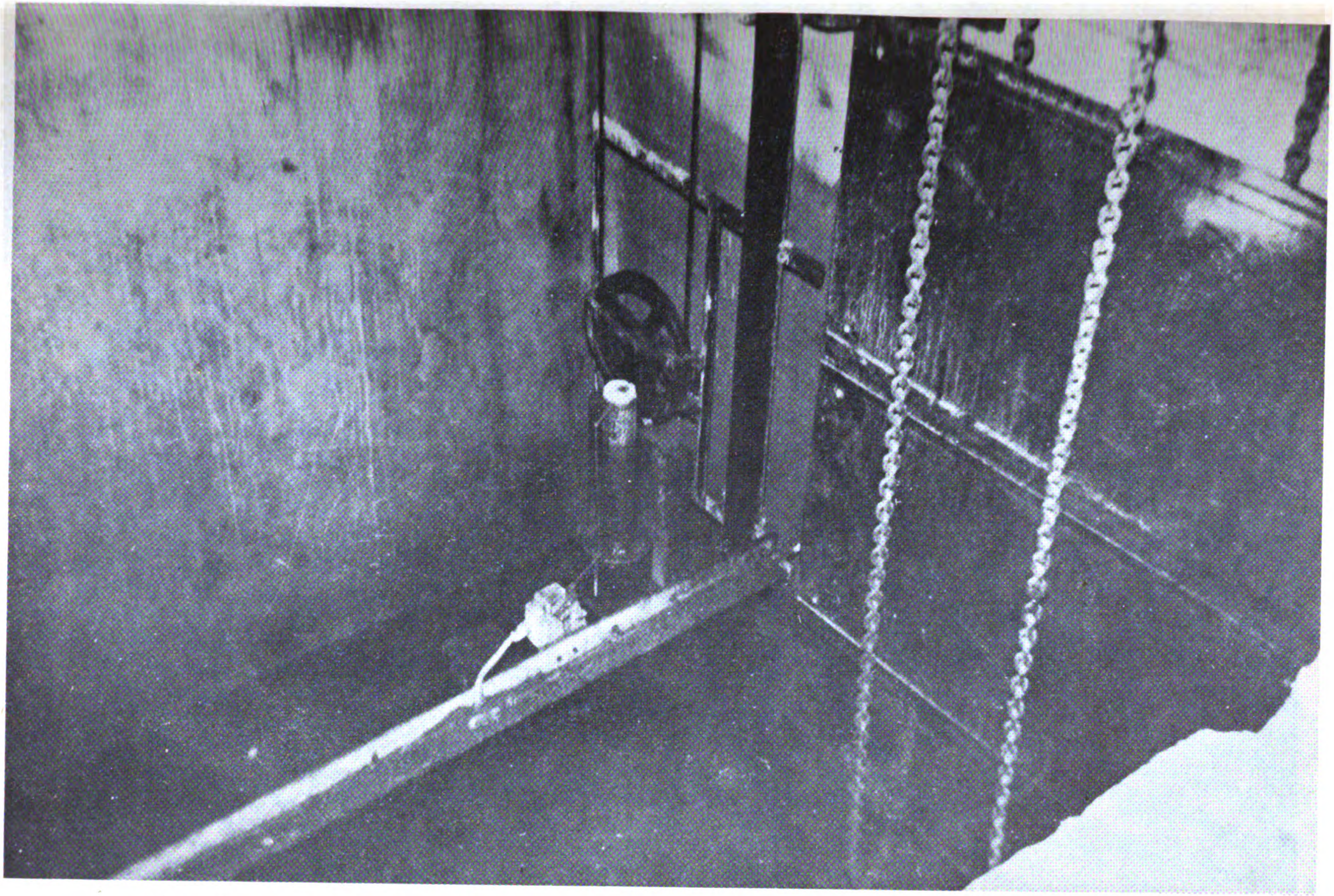

Figure 10. - View of shaft showing one of oil-filled buffers, governor cable, and counterbalance chains.

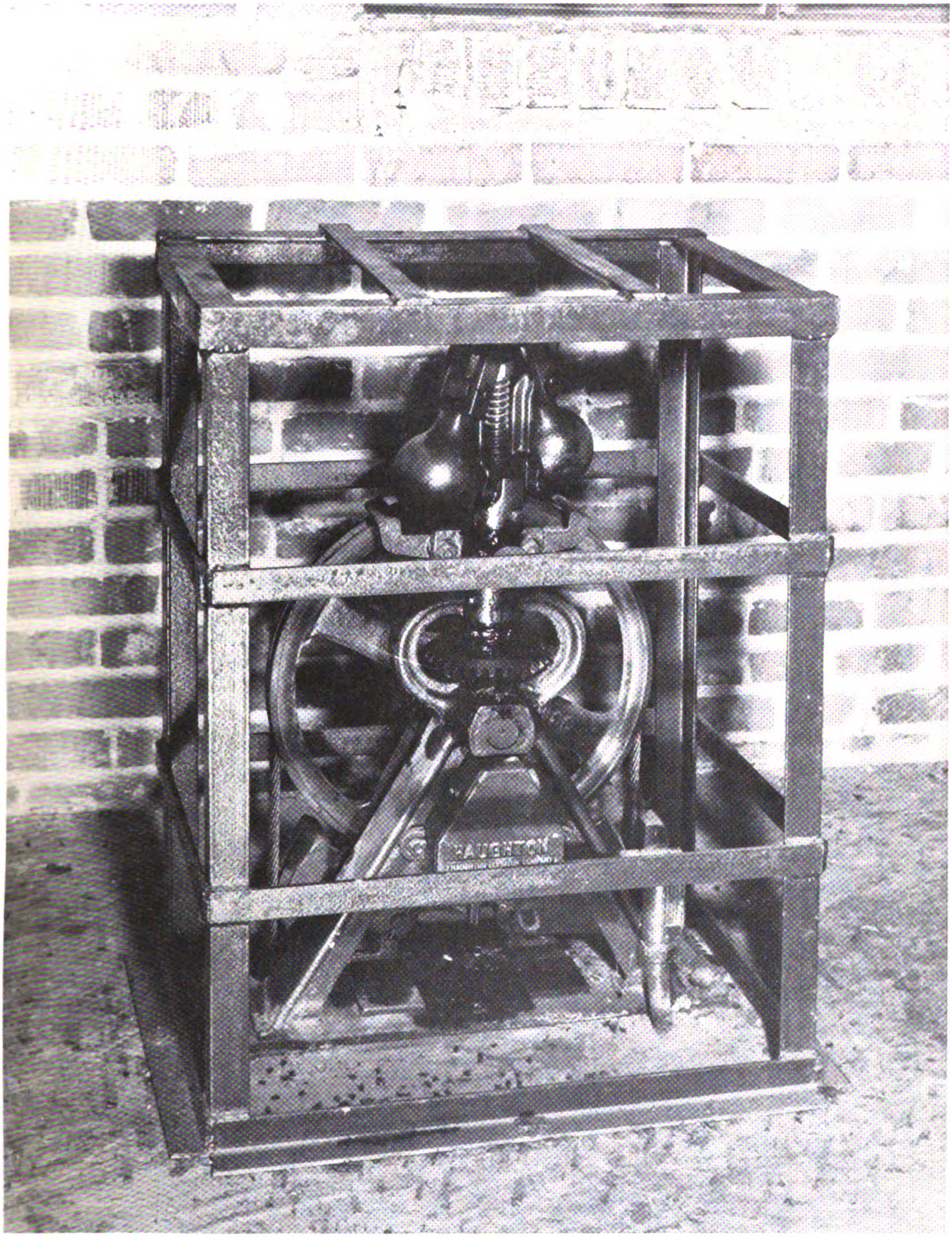

Figure 11. - Fly-ball governor surrounded by metal guard.

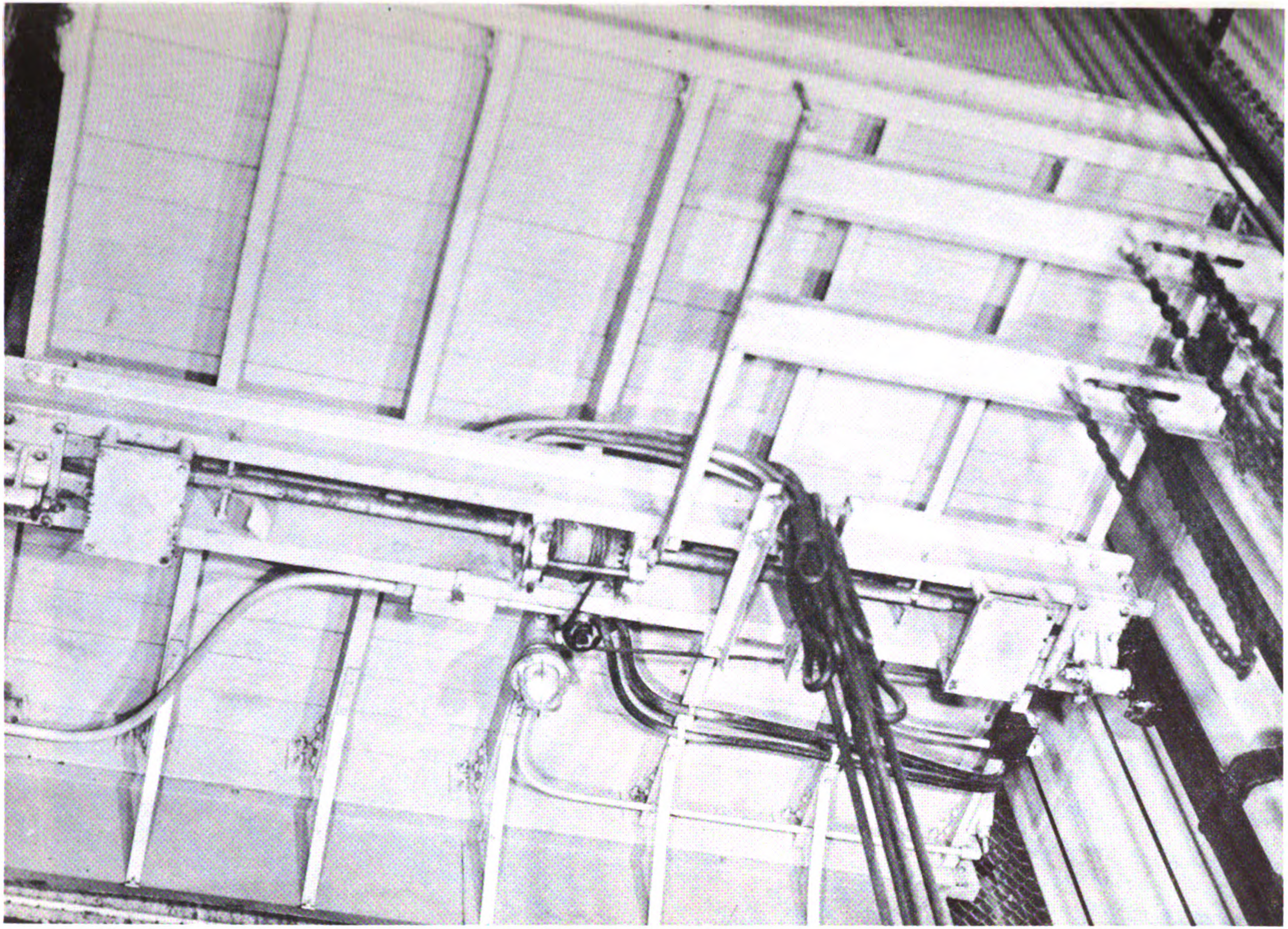

Figure 12. - View of bottom of car, showing electric-control cables overspeed safety device, and counterbalance chains.

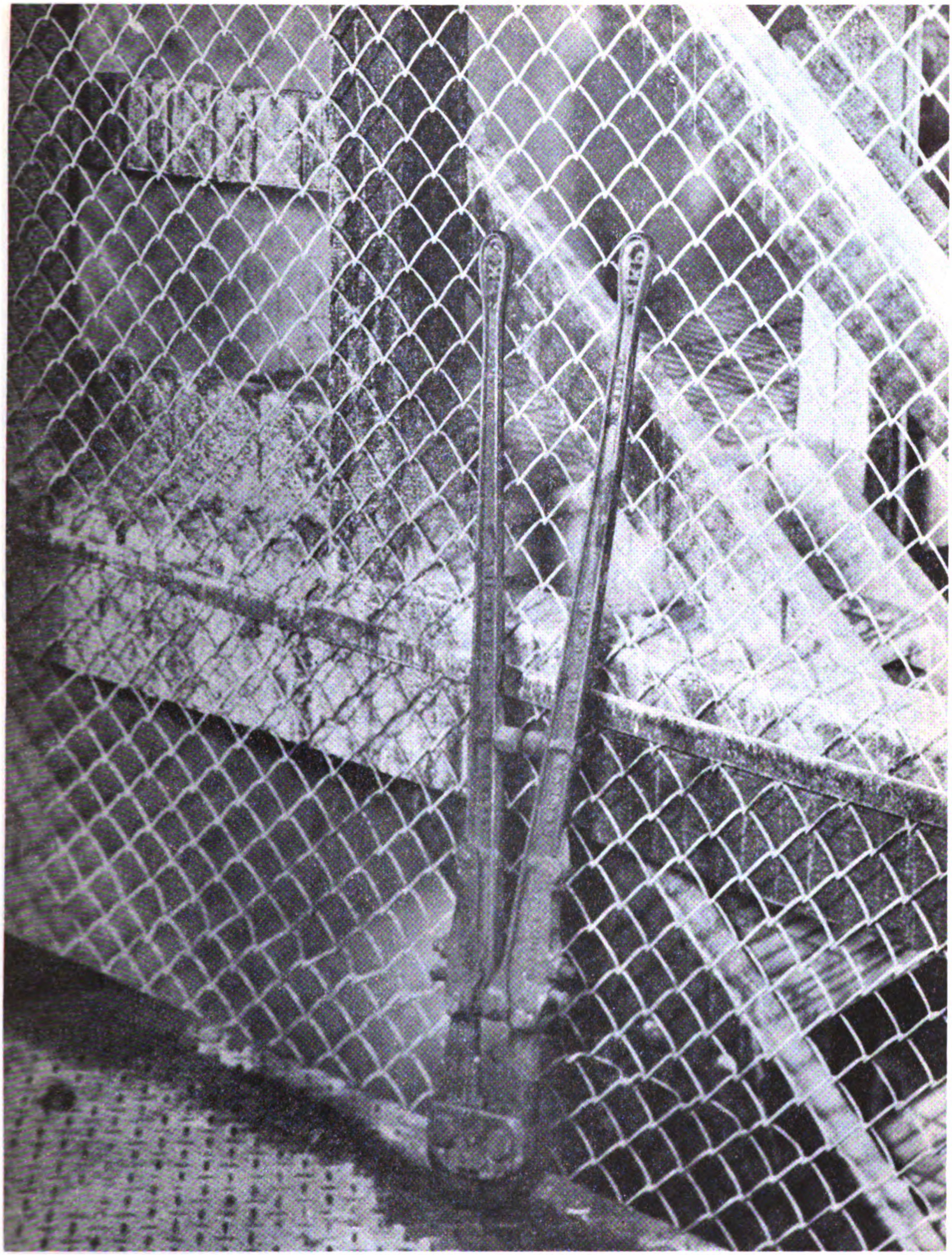

Figure 13. - View from car between landings, showing screened stairway and bolt cutter for emergency escape.

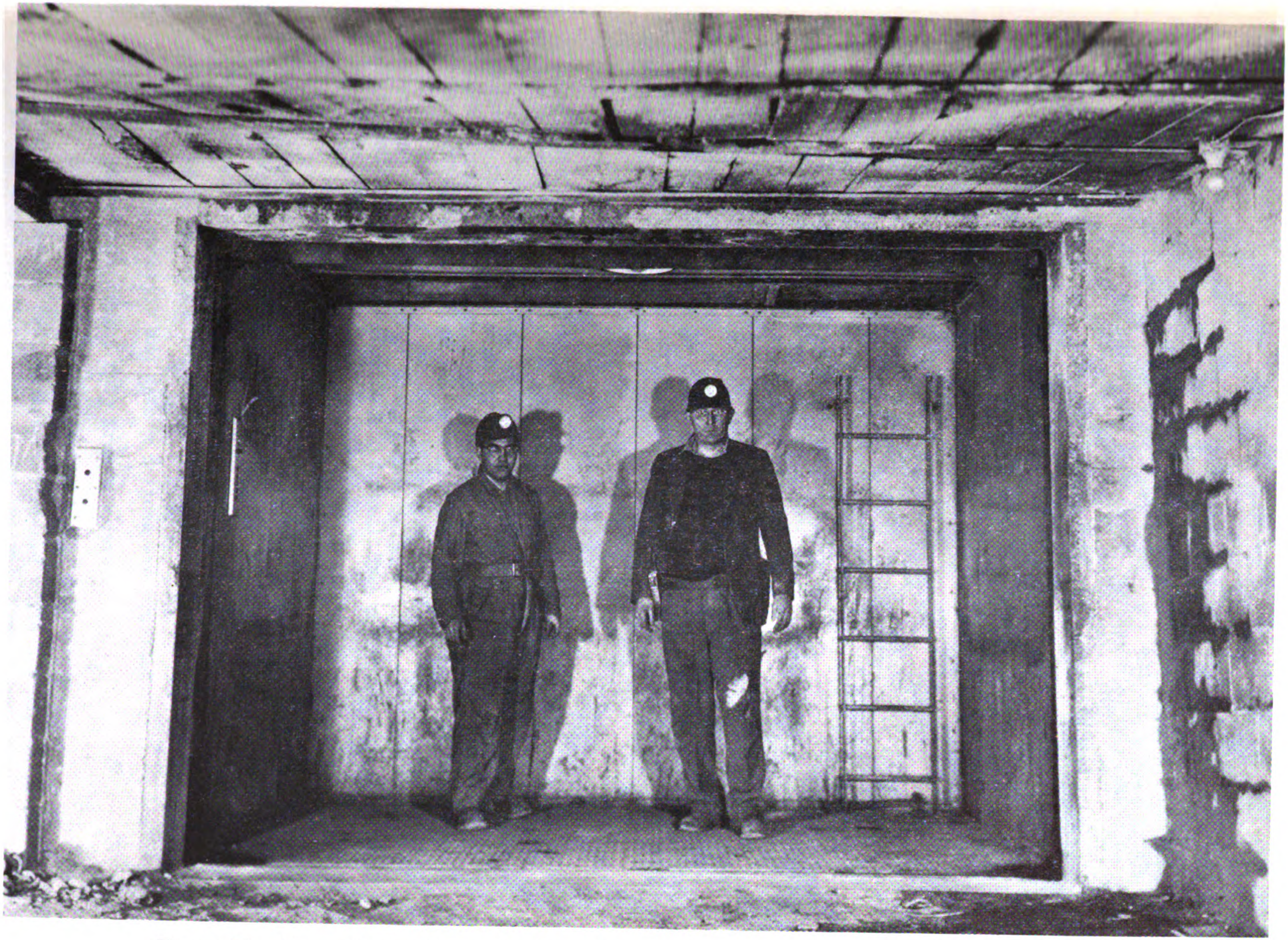

Figure 14. - View of car at bottom landing, showing escape-hatch ladder fastened to back of car.

ESCAPE PROVISIONS

In the Pine Run shaft, the elevator-car-door opening faces a steel-mesh wire screen provided on one side of the stairway. If the car stops between landings because of power failure or other causes, the passengers can escape to the stairway by forcing open the elevator door and cutting a hole in the screen with bolt cutters, which are kept on the car for that purpose (fig.13).

The door opening in the Butler Junction shaft elevator car faces the concrete end of the shaft; therefore, an escape hatch is provided in the top of the car. By climbing a ladder secured to the back of the car and raising the escape hatch, the passengers can get on top of this car (fig. 14). Bolt cutters are provided on top so that the screen on the side of the stairway can be cut, permitting the passengers to reach the surface by walking up the stairway.

PRESENT OPERATING PROCEDURE

The procedure for lowering and hoisting men in these shafts is as follows: Two designated employees ride down in the car, and one is left on the bottom; the second man remains on the car and operates it while the other employees are taken down; a third man stays at the surface landing, directing the employees into the car, accompanies the last carload down, and returns the car to the surface, where he remains within hearing distance of the signal bell while the men are working underground. He is available at all times during the working shifts to take the car to the bottom and bring any person to the surface who desires to come out. At the close of the working shift, one designated employee stays at the bottom of the shaft, directing the employees into the car while another operates the car, hoisting the employees to the surface. The bottom man comes to the surface with the last carload.

CONCLUSIONS

The installation of these automatic electrically controlled elevator cars for the ingress and egress of the employees is a great step forward in safety and is a very commendable improvement over the ordinary conventional coal- and man-hoisting cages in operation at most mines. It is hoped that other mining companies contemplating future shaft installations will include a like means for transporting men into and out of mines. In considering this means of transportation, it must be remembered that the first cost is relatively low, the operating cost and the operating personnel are less, and shaft accidents should be reduced as compared with the conventional methods of transporting men in shafts using the ordinary hoisting cages.

OUTSTANDING SAFETY FEATURES

The following outstanding safety features afforded by automatic elevators are believed worthy of special consideration:

1. The cars stop automatically at landings.
2. The cars cannot be overwound.
3. Overspeed controls and safety devices are provided.
4. The passengers cannot fall from the cars.
5. The operation can be either automatic or semiautomatic.
6. The doors cannot be inadvertently opened while the car is in motion. If the doors are forced open, the car will immediately stop.